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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/596,022	05/25/2006	Toshiharu Furukawa	FIS920030339US1	1812

32074 7590 10/01/2010

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EXAMINER	
GEBREYESUS, YOSEF	

ART UNIT	PAPER NUMBER
2811	

NOTIFICATION DATE	DELIVERY MODE
10/01/2010	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

EFIPLAW@US.IBM.COM

Office Action Summary	Application No.	Applicant(s)	
	10/596,022	FURUKAWA ET AL.	
	Examiner	Art Unit	
	YOSEF GEBREYESUS	2811	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *21 September 2010*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-20* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-20* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *25 May 2006* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Oath/Declaration

1. The Oath/Declaration filed on 5/25/2006 is acceptable.

Specification

2. The specification has not been checked to the extent necessary to determine the presence of all possible minor errors. Applicant's cooperation is requested in correcting any errors of which applicant may become aware in the specification.

Claim Rejections - 35 USC § 103

3. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

4. The factual inquiries set forth in *Graham* v. *John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

5. Claims 1-5, 7-8, 10-13, 15 and 17-19, are rejected under 35 U.S.C. 103(a) as being unpatentable over Stamper (US 2002/0130388, dated September 19th, 2002, filed

March 19th, 2001) in view of Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereinafter Smalley) further in view of Lee et al. (US 2002/0048143, dated April 25th, 2002, filed March 15th, 2001; hereinafter Lee).

6. Regarding **claim 1**, figures 1-6 and related text of Stamper discloses a substrate 15/20 (paragraph [0032]); a trench 31 in said substrate 15/20; multiple conductive layer 32/44 (first conductive layer 32 and metal liner 44) (paragraph [0044]) lining said trench 31; and a trench conductor 46/48 (paragraph [0048]), surrounded by and in direct contact with said conductive layer 44, filling said trench 31, wherein said trench conductor 46/48 and said substrate 15/20 having a co-planar top surface.

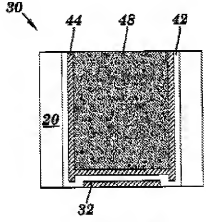

FIG. 6

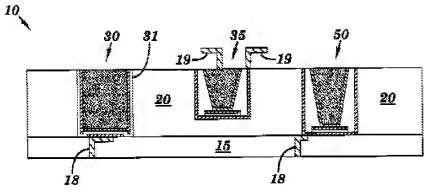

FIG. 1

Stamper does not disclose the conductive metal liner is a conductive carbon nanotubes.

However, in the same field of endeavor Smalley discloses, a similar device wherein the capacitor electrode is formed of conductive carbon nanotubes (Smalley; paragraph [0018] & [0029] lines 1-10]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the metal liner material of Stamper's device with carbon nanotubes as taught by Smalley. The ordinary artisan would have been motivated to modify Stamper's device in the above manner because purified carbon nanotubes are stable and resistant to environment attack (Smalley; paragraph [0023] lines 1-4), thus enhancing the performance of the device (Smalley; paragraph [0018]).

Furthermore, Smalley does not show the structure of carbon nonotubes in the device.

However, in the same field of endeavor, figure 1 and related text of Lee discloses a similar device wherein the electrodes are formed of vertical multiple carbon nanotubes 100 (Lee; paragraph [0020], [0024]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form vertical multiple carbon nanotubes in the combination device of Stamper and Smalley. The ordinary artisan would have been motivated to modify the combination of Stamper and Smalley's device in the above manner in order to increase the capacitance of the capacitor (Lee; paragraph [0006], [0009]).

7. Regarding **claim 2**, figures 1-6 and related text of Stamper discloses a substrate 15/20; at least one trench 31 in said substrate 15/20; multiple conductive layer 32/44 (first conductive layer 32 and metal liner 44) (paragraph [0044]) lining said at least one trench 31; a trench conductor 46/48 filling said at least one trench 31 and in direct contact with said multiple conductive layer 44; and a trench dielectric 42 between said multiple conductive layers 44 and sidewalls of said at least one trench 31 and directly underneath and in contact with said multiple conductive layer 44.

Stamper does not disclose the conductive metal liner is a conductive carbon nanotubes.

However, in the same field of endeavor Smalley discloses, a similar device wherein the capacitor electrode is formed of conductive carbon nanotubes (Smalley; paragraph [0018] & [0029] lines 1-10]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the metal liner material of Stamper's device with carbon nanotubes as taught by Smalley. The ordinary artisan would have been motivated to modify Stamper's device in the above manner because purified carbon nanotubes are stable and resistant to environment attack (Smalley; paragraph [0023] lines 1-4), thus enhancing the performance of the device (Smalley; paragraph [0018]).

Furthermore, Smalley does not show the structure of carbon nonotubes in the device.

However, in the same field of endeavor, figure 1 and related text of Lee discloses a similar device wherein the electrodes are formed of vertical multiple carbon nanotubes 100 (Lee; paragraph [0020], [0024]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form vertical multiple carbon nanotubes in the combination device of Stamper and Smalley as taught by Lee. The ordinary artisan would have been motivated to modify the combination of Stamper and Smalley's device in the above manner in order to increase the capacitance of the capacitor (Lee; paragraph [0006], [0009]).

8. Regarding **claim 3**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose further comprising a layer of trench dielectric 42 (Fig. 1 of Stamper) (paragraph [0043]) on top of a bottom of said trench 31 (Fig. 1 of Stamper) and between said multiple conductive carbon nanotubes (conductive layer) 42 (Fig. 1 of Stamper) and sidewalls of said trench 31(Fig. 1 of Stamper), wherein the multiple conductive

carbon nanotubes (conductive layer) 42 (Fig. 1 of Stamper) form an open cylinder structure lining said sidewalls of said trench 31 through said layer of trench dielectric 42 (Fig. 1 of Stamper).

9. Regarding **claim 4**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose wherein the trench conductor 48 (Fig. 1 of Stamper) comprises a metal (paragraph [0045), contacting (electrically, capacitor forms electric field in the dielectric) said layer of trench dielectric 42 (Fig. 1 of Stamper) on top of said bottom of said trench 31 (Fig. 1 of Stamper).

10. Regarding **claim 5**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the multiple conductive carbon nanotubes (conductive layer) 44 (Fig. 1 of Stamper) and the trench conductor 48 (Fig. 1 of Stamper) are disposed in the trench 31 (Fig. 1 of Stamper), and the trench conductor 48 (Fig. 1 of Stamper) is carbon free (copper) (Stamper, paragraph [0045]).

11. Regarding **claim 7**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the multiple conductive carbon nanotubes (conductive layer) 42 (Fig. 1 of Stamper) form a consistent lining along approximately the entire length of sidewalls of said trench 31 (Fig. 1 of Stamper).

12. Regarding **claim 8**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the trench-type storage device (Fig. 1 of Stamper) is planarized so that a top surface of the substrate 15/20 (Fig. 1 of Stamper) is coplanar with respective top surfaces of the trench dielectric 42 (Fig. 1 of Stamper), the

multiple conductive carbon nanotubes 44 (Fig. 1 of Stamper) and the trench conductor 48 (Fig. 1 of Stamper).

13. Regarding **claim 10**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose a trench dielectric 42 (Fig. 1 of Stamper) between said multiple conductive carbon nanotubes 44 (Fig. 1 of Stamper) and sidewalls of said trench 31 (Fig. 1 of Stamper).

14. Regarding **claim 11**, figures 1-6 and related text of Stamper discloses a substrate 15/20; one trench 31 in said substrate 15/20; a trench conductor (conductive layer) 44 (metal liner 44) (paragraph [0044]) forming an open cylinder in lining said one trench 31; and a trench conductor 48 filling said open cylinder of said conductive layer 44 and in direct contact with said conductive layer 44, wherein said trench conductor 44 and said substrate 15/20 having a co-planar top surface.

Stamper does not disclose the conductive metal liner is a conductive carbon nanotubes.

However, in the same field of endeavor Smalley discloses, a similar device wherein the capacitor electrode is formed of conductive carbon nanotubes (Smalley; paragraph [0018] & [0029] lines 1-10]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to replace the metal liner material of Stamper's device with carbon nanotubes as taught by Smalley. The ordinary artisan would have been motivated to modify Stamper's device in the above manner because purified carbon

nanotubes are stable and resistant to environment attack (Smalley; paragraph [0023] lines 1-4), thus enhancing the performance of the device (Smalley; paragraph [0018]).

Furthermore, Smalley does not show the structure of carbon nonotubes in the device.

However, in the same field of endeavor, figure 1 and related text of Lee discloses a similar device wherein the electrodes are formed of vertical multiple carbon nanotubes 100 (Lee; paragraph [0020], [0024]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form vertical multiple carbon nanotubes in the combination device of Stamper and Smalley as taught by Lee. The ordinary artisan would have been motivated to modify the combination of Stamper and Smalley's device in the above manner in order to increase the capacitance of the capacitor (Lee; paragraph [0006], [0009]).

15. Regarding **claim 12**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose wherein the trench conductor 48 (Fig. 1 of Stamper) comprises a metal (paragraph [0045), contacting (electrically, capacitor forms electric field in the dielectric) said layer of trench dielectric 42 (Fig. 1 of Stamper) on top of said bottom of said trench 31 (Fig. 1 of Stamper).

16. Regarding **claim 13**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the multiple conductive carbon nanotubes (conductive layer) 44 (Fig. 1 of Stamper) and the trench conductor 48 (Fig. 1 of

Stamper) are disposed in the trench 31 (Fig. 1 of Stamper), and the trench conductor 48 (Fig. 1 of Stamper) is carbon free (copper) (Stamper, paragraph [0045]).

17. Regarding **claim 15**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the multiple conductive carbon nanotubes (conductive layer) 42 (Fig. 1 of Stamper) form a consistent lining along approximately the entire length of sidewalls of said trench 31 (Fig. 1 of Stamper).

18. Regarding **claim 17**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose a trench dielectric 42 (Fig. 1 of Stamper) between said multiple conductive carbon nanotubes 44 (Fig. 1 of Stamper) and sidewalls of said trench 31 (Fig. 1 of Stamper).

19. Regarding **claim 18**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose a trench dielectric layer 42 (Fig. 1 of Stamper) directly underneath said multiple conductive carbon nanotubes 44 (Fig. 1 of Stamper).

20. Regarding **claim 19**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose wherein said trench dielectric layer 42 lining at least a substantial portion of sidewalls of said trench 31 and said multiple conductive carbon nanotubes 44 lining said trench 31 via said trench dielectric layer 42 (Fig. 1 of Stamper).

21. Claims 6 and 14, are rejected under 35 U.S.C. 103(a) as being unpatentable over Stamper (US 2002/0130388, dated September 19th, 2002, filed March 19th, 2001) in view of Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereinafter Smalley) and Lee et al. (US 2002/0048143, dated April 25th, 2002,

filed March 15th, 2001) further in view of Brenstein et al. (US 2002/0151150, dated October 17th, 2002, filed October 26th, 2001; hereinafter Brenstein).

22. Regarding **claim 6**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the substrate 15/20 (Fig. 1 of Stamper).

The combination of Stamper, Smalley and Lee do not disclose the substrate is free of carbon nanotube catalyst materials.

However, in the same field of endeavor, figures 1-6 and related text of Brenstein discloses the substrate 10/12 is free of carbon nanotube catalyst materials (silicon and silicon dioxide or SOI substrate) (paragraph [0022] lines 1-5).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination device of Stamper's, Smalley's and Lee's substrate with free of carbon nanotube catalyst materials (silicon and silicon dioxide) as taught by Brenstein. The ordinary artisan would have been motivated to use such material to form the substrate of the combination device of Stamper's, Smalley's and Lee's, because silicon and silicon dioxide materials are conventional and known substrate materials.

23. Regarding **claim 14**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose characterized in that the substrate 15/20 (Fig. 1 of Stamper).

The combination of Stamper, Smalley and Lee do not disclose the substrate is free of carbon nanotube catalyst materials.

However, in the same field of endeavor, figures 1-6 and related text of Brenstein discloses the substrate 10/12 is free of carbon nanotube catalyst materials (silicon and silicon dioxide or SOI substrate) (paragraph [0022] lines 1-5).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination device of Stamper's, Smalley's and Lee's substrate with free of carbon nanotube catalyst materials (silicon and silicon dioxide) as taught by Brenstein. The ordinary artisan would have been motivated to use such material to form the substrate of the combination device of Stamper's, Smalley's and Lee's, because silicon and silicon dioxide materials are conventional and known substrate materials.

24. Claims 9 and 16 are rejected under 35 U.S.C. 103(a) as being unpatentable over Stamper (US 2002/0130388, dated September 19th, 2002, filed March 19th, 2001) in view of Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereinafter Smalley) further in view of Lee et al. (US 2002/0048143, dated April 25th, 2002, filed March 15th, 2001; hereinafter Lee) Yoshikazu Homma ("Growth of suspended carbon nanotube..." dated 09/16/2002, hereinafter Homma)

25. Regarding **claim 9 and 16**, the combination of Stamper, Smalley and Lee substantially disclose the claimed invention except the multiple conductive carbon nanotubes (conductive material) are grown downwards into the trench.

However, in the same field of endeavor Homma discloses growing nanotubes downward (page 2263, 5th paragraph).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to grow the multiple conductive carbon nanotubes of the combination of Stamper's, Smalley's and Lee's device down wards as taught by Homma. The ordinary artisan would have been motivated to grow the nanotubes in the above manner for the purpose of forming vertical nanotubes without having arches at the top portion of the nanotube (page 2263 col. 2 lines 15-19).

26. Claim 20, is rejected under 35 U.S.C. 103(a) as being unpatentable over Stamper (US 2002/0130388, dated September 19th, 2002, filed March 19th, 2001) in view of Smalley et al. (US 2002/0159944, dated October 31st, 2002, filed February 8th, 2002; hereinafter Smalley) and Lee et al. (US 2002/0048143, dated April 25th, 2002, filed March 15th, 2001; hereinafter Lee) and further in view of Widmann et al. (US 2001/0012658, dated August 9th, 2001, filed April 14th, 2001; hereinafter Widmann).

27. Regarding **claim 20**, figures 1-6 and related text of Stamper in view of Smalley and Lee disclose wherein said trench dielectric layer 42 (Fig. 1 of Stamper) having a shape, lined by said multiple conductive nanotubes (plurality of conductive layer) 32/44 (Fig. 1 of Stamper) across sidewalls of said shape, and filled by said trench conductor 48 (Fig. 1 of Stamper).

The combination of Stamper, Smalley and Lee do not explicitly disclose the trench dielectric is formed of cylindrical shape.

However, in the same field of endeavor Widmann discloses a similar device wherein a trench dielectric is formed of cylindrical shape (paragraph [0014]).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to form the combination of Stamper's, Smalley's and Lee's device trench dielectric with a cylindrical shape as taught by Widmann. The ordinary artisan would have been motivated to modify the combination of Stamper's, Smalley's and Lee's device in the above manner in order to increase the surface area of the storage electrode which results in high capacitance of the capacitor.

Response to Arguments

28. Applicant's amendment filed on 9/21/2010, overcame the objection to claim 2. Accordingly the objection to claim 2 has been withdrawn.

29. Claims 1-2 and 18-20 as amended by the amendment dated 09/21/2010, and claims 3-17 as previously recited are currently in the application.

30. Applicant's arguments, see Applicant's Arguments/Remarks, filed 9/21/2010, with respect to claims 1, 2 and 11 have been fully considered and are persuasive. Therefore the U.S.C 103(a) rejection of Bernstein in view of Smalley has been withdrawn. However, upon further consideration a new ground of rejection is established Stamper in view of Smalley and further in view of Lee.

31. Applicant's arguments with respect to claims 1, 2 and 11 have been considered but are moot in view of the new ground(s) of rejection. The examiner would like to emphasize the new ground(s) or rejection is established because applicant has added the limitation "and in direct contact with" in claims 1, 2 and 11 in the amendment dated 05/13/2010. The examiner is required to use the broadest reasonable interpretation

consistent with the specification in order to examine the amended claims (MPEP 2111). The detail of the examination is listed in the office action.

Conclusion

32. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to YOSEF GEBREYESUS whose telephone number is (571)270-5765. The examiner can normally be reached on Monday through Thursday 7:30 to 5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Lynne A. Gurley can be reached on 571-272-1670. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/Lynne A. Gurley/
Supervisory Patent Examiner, Art Unit 2811

/YOSEF GEBREYESUS/
Examiner, Art Unit 2811
09/24/2010